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RECOVERY OF GOLD FROM LAKE CHARLOTTE TAILING (N.S.)

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RECOVERY OF GOLD FROM LAKE CHARLOTTE TAILING (N.S.)

by

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ABSTRACT

An ore sample originating from the Lake Charlotte tailing pond in Nova Scotia and containing about 14 g/t Au was examined for gold extraction. Three technological concepts were investigated: flotation, direct cyanidation and flotation followed by the cyanidation of the concentrate. Although all three technologies achieved gold recoveries in excess of 90%, the cyanidation of the flotation concentrate was considered the best approach for treating this material. Continuation of the testwork was proposed to study the extraction of gold from the cyanide solution by the carbon-in-pulp adsorption technique.

RÉSUMÉ

On a examiné les possibilités d'extraire l'or d'un échantillon de minerai aurifère provenant du bassin de rejet des stériles de Lake Charlotte, en Nouvelle-Écosse; cet échantillon contenait environ 14 g/t d'Au. On a examiné trois procédés techniques: la flottation, la cyanuration directe et la flottation suivie de la cyanuration du concentré. Bien que ces trois méthodes permettent d'extraire l'or à plus de 90%, on a considéré que la cyanuration du concentré obtenu par flottation était le traitement le plus valable. On a proposé de continuer les expériences, pour étudier l'extraction de l'or dans une solution de cyanure par la technique d'adsorption, avec addition de carbone aux boues de minerai.

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INTRODUCTION

In the last years, following CANMET recommendations, a project was initiated to locate, in Canada, abandoned gold-silver tailing dumps of potential economic interest and to investigate the possibility of recovering the precious metals from these old deposits, by modern techniques.

Nova Scotia was one location in Canada where numerous gold processing plants were in operation in the early days. Before 1900 the milling practice consisted mainly of amalgamation and gravity concentration. Flotation and cyanidation were introduced at the turn of the century.

A literature search of the Nova Scotia gold milling practice indicated that the metal recovery in the old flotation and cyanidation plants was very good, therefore the tailing ponds resulting from those operations would, very likely, be of little or no economic importance. However, the gold recovery at the amalgamation and gravity concentration plants appeared to be lower, indicating the possibility that significant amounts of recoverable gold would have been carried with the tailings to the dump sites.

Following these findings particular attention was given to the old tailing ponds resulting from amalgamation or gravity concentration. Among the tailing dumps that belonged to this category was the area identified as Lake Charlotte. There were indications that the gold content of this tailing pond was quite high, but the actual size of the deposit was unclear. Investigation, through the Nova Scotia Department of Mines and Energy, is still in progress to determine the available reserves of gold tailing at this area.

A sample from the Lake Charlotte area was submitted to CANMET in the summer of 1981 for laboratory testwork. This report covers the results of the investigtion carried out on this tailing sample.

OUTLINE OF INVESTIGATION

The testwork presented in this report is part of the investigation program intended to explore the possibilities of recovering the gold and silver values from old tailing ponds across Canada.

OBJECTIVES OF THE INVESTIGATION

A sample of gold tailings from Lake Charlotte, N.S. was received for testwork. The objectives of this investigation were as follows:

a) to determine the chemico-mineralogical characteristics of the tailings sample with respect to precious metals mineralization;

b) to investigate the possibility of recovering the precious metals from the tailing sample.

TESTWORK CONDITIONS AND RESULTS

The head assay of the sample indicated a high gold content (14 g/t Au), minor amount of silver (1.1 g/t Ag) and very little sulphides (0.06% S).

The mineralogical examination of the sample identified the presence of native gold which occurred essentially as inclusions in silicates (1-90 μm) or as liberated grains (10-180 μm).

The extraction of gold from the tailing sample was studied using three technological schemes:

a) flotation,

b) cyanidation of the entire ore,

c) flotation followed by the cyanidation of the flotation concentrate.

The optimum conditions and results of these investigations are presented in Table 1.

The response of the ore to these technological processes was very good, the gold extraction exceeding 90% in all the cases. However, the recommended method of treating this tailing ore was flotation followed by the cyanidation of the flotation concentrate. The reasons for selecting this technology against flotation or cyanidation, as single processes were:

a) The smelters prefer to process high grade gold cyanidation precipitates rather than relatively low grade flotation concentrate.

b) Cyaniding the flotation concentrate (8.4% by weight) rather than the entire ore is likely to present a significant economic advantage, despite the extra cost of flotation and somewhat lower gold extraction.

Table 1 - Summary of the optimum conditions and results

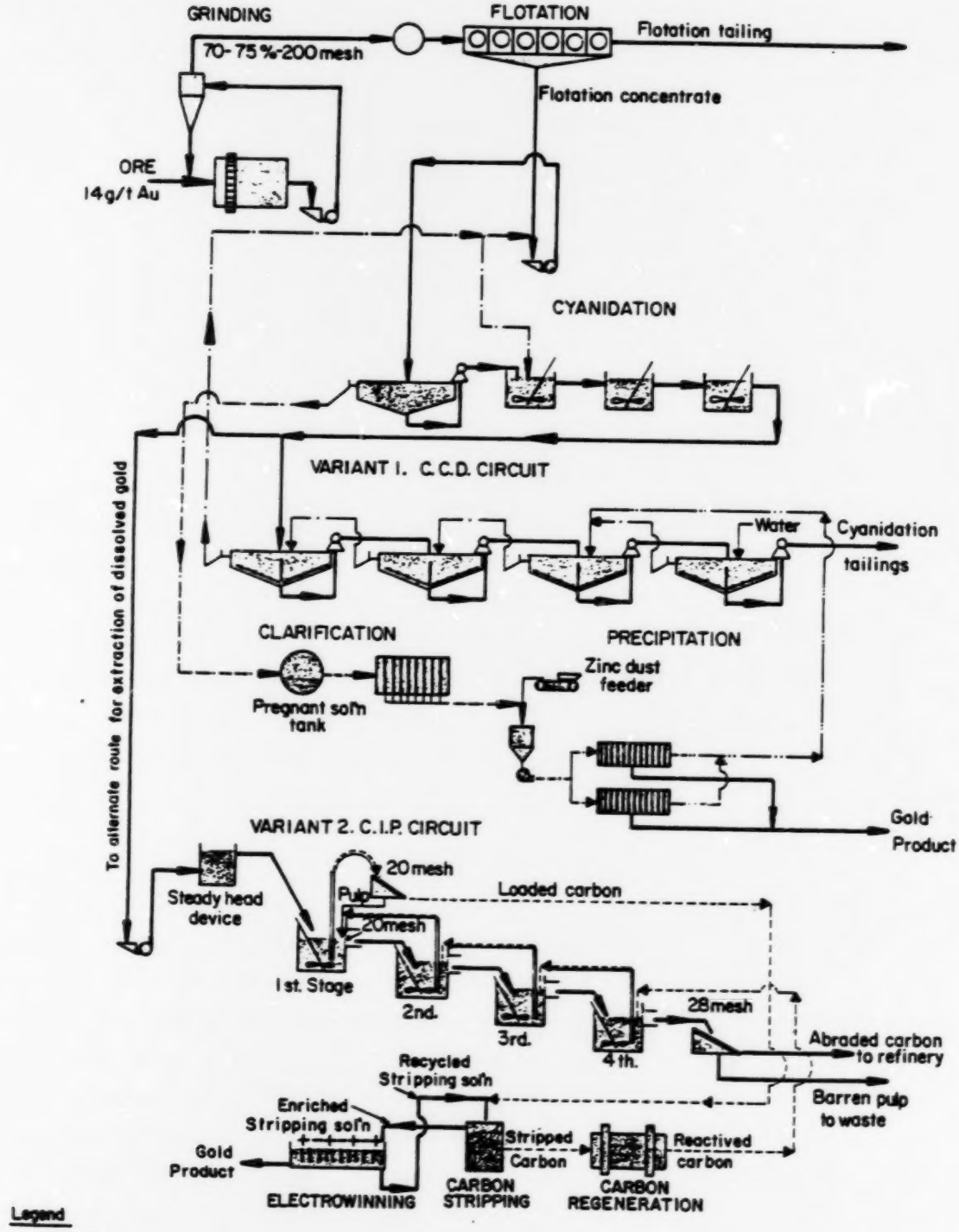
Technology	CONDITIONS				RESULTS				
	Grind % -200 mesh	Reagents		pH	Products	% Weight	Assay Au g/t, mg/L	% Dist. Au	
		Type	g/t					Ind.	O/A
Flotation	73.8	Aerofloat 208	300	6.1	Head	100.0	14.3		100.0
		Xanthate 317	150		Conc	8.4	159.5		93.8
		MIBC**	100		Tails	91.6	1.0		6.2
Cyanidation 24 hours	73.8	NaCN	500	11	Head	100.0	13.3		100.0
		CaO	4200		Cynd. Sol'n	-	3.9		96.9
					Residue	100.0	0.4		3.1
Flotation and Concentrate	73.8	Aerofloat 208	300	6.1	Head	100.0	12.7	100.0	100.0
		Xanthate 317	150		Flot. Conc	12.0	97.7	92.4	-
		MIBC**	100		Flot. Tails	88.0	1.1	7.6	7.6
Cyanidation 48 hours	100.0*	NaCN	368	11	Flot. Conc	12.0	97.7	100.0	92.4
		CaO	1300		Cynd. Sol'n	-	23.8	98.5	91.0
					Residue	12.0	1.3	1.5	1.4

* Also 96% -400 mesh (this was the fineness of the concentrate as resulting from the flotation test, without any regrind)

** Methylisobutylcarbinol

The recommended flowsheet sketched in Fig. 1 consists of: grinding the tailing ore to approximately -100 mesh (70-75% -200 mesh), bulk flotation, thickening of the flotation concentrate followed by 48 hours cyanidation of the concentrate, solid-liquid separation of the cyanide leached slurry and gold precipitation from the clarified solution. Adsorption of gold by carbon-in-pulp technique is an alternate route that could be considered for recovering the precious metal from cyanide leach slurry. However neither solid-liquid separation nor carbon-in-pulp gold adsorption have been studied at this time.

Figure I. RECOMMENDED FLOWSHEET FOR PROCESSING LAKE CHARLOTTE GOLD TAILINGS WITH 2 VARIANTS FOR EXTRACTION OF DISSOLVED GOLD



CONCLUSIONS AND RECOMMENDATIONS

Based on the results of the testwork performed on Lake Charlotte tailing sample the following conclusions can be drawn:

a) The assay of the tailing sample indicated the possibility of dealing with an interesting gold deposit. However, the representativeness of this sample and the size of the tailing deposit must be established before undertaking more work, including economic evaluations, on this material.

b) The testwork performed on the tailing sample has shown that over 90% of the gold contained in this material could be recovered by flotation, cyanidation or a combination of both. More work is required to optimize the basic conditions for the selected technology and to investigate the optimum approach for gold extraction from cyanide leach slurry.

The following recommendations are offered, for the continuation of the test program on Lake Charlotte tailing, provided that an estimate of the size of the deposit, to justify further work, can be made.

a) Continue the laboratory investigation to study and compare C.C.D. (counter-current decantation) and precipitation process with carbon-in-pulp technique for gold extraction from cyanide leach slurry.

b) Optimize conditions, select and finalize one or two flowsheet variants based on the results of the bench-scale experiments.

c) Obtain a large sample from the tailing pond and verify the laboratory conditions of the selected flowsheets, in C.P.D.U. (continuous process development unit).

d) Based on the metallurgical data and the information obtained as regards the size and the grade of the tailing pond a cost estimate should be prepared to evaluate the economics of the selected technologies.

DETAILED DESCRIPTION OF THE TESTWORK

A sample of about 100 kg was received from Lake Charlotte tailing pond for testwork. The sample contained a large quantity of foreign matters (roots, wood, etc.) which were removed by screening the entire material. Then, the ore was thoroughly mixed and samples for chemical assay, mineralogy and testwork were riffled out.

HEAD ASSAY

The assay of the head sample is presented in Table 2.

Table 2 - Head assay

Element	Assay %	Element	Assay g/t	Assay oz/st
Pb	0.01	Au	14	0.41
Cu	0.01	Ag	1.13	0.03
Zn	0.01			
S	0.06			
Fe	2.96			
As	0.35			
Ca	0.84			
Mg	0.77			
CO_2	1.14			

As can be seen from this assay gold was the only element of interest in the sample.

The direct assay of the sample indicated a content of 17 g/t Au (0.5 oz/st), however almost all the calculated head assays throughout the testwork were in the 14 g/t range. Therefore, it was decided to accept this value as the average gold content of the sample.

The sulphur content was very low showing a minor amount of sulphides in the ore.

MINERALOGICAL EXAMINATION

The microscopic investigation of the tailing sample identified the presence of native gold which occurred as liberated grains, inclusions in silicates and to a much lesser degree as inclusions in arsenopyrite.

The inclusions and liberated grains ranged in size from less than 1 µm to approximately 90 µm and from 10 to 180 µm respectively.

The presence of mercury in the sample indicated that this material had been previously exposed to amalgamation process.

The complete results of the microscopic examination are contained in the mineralogical report presented in Appendix 1.

SIZE AND GOLD DISTRIBUTION IN THE TAILING SAMPLE

The structure of the tailing sample is given in Table 3.

Table 3 - Structure of the sample

Size		% Retained		% Pass
Mesh	Microns	Ind*	Cum**	Cum**
+ 48	297	9.0	9.0	91.0
65	210	8.4	17.4	82.6
100	149	13.3	30.7	69.3
150	105	10.8	41.5	58.5
200	74	12.8	54.3	45.7
270	53	7.9	62.2	37.8
325	44	5.8	68.0	32.0
400	37	8.6	76.6	23.4
500	30	9.8	86.4	13.6
- 500		13.6	100.0	-
Total		100.0	-	-

* Individual
* Cumulate

The sieve analysis indicated that almost half of the material was passing through 200 mesh screen and about a quarter reported in the -400 mesh fraction.

The gold distribution in the tailing sample is shown in Table 4.

Table 4 - Gold distribution per size fractions

Size		% Weight	Assay	% Dist.
Mesh	Microns	Retained	Au, g/t	Au
+ 48	297	9.0	36.3	18.9
65	210	8.4	22.8	11.1
100	149	13.3	11.7	15.8
150	105	10.8	8.9	5.6
200	74	12.8	7.9	5.9
270	53	7.9	9.3	4.3
325	44	5.8	13.1	4.4
400	37	8.6	11.9	5.9
500	30	9.8	14.3	8.1
- 500		13.6	25.4	20.0
Total		100.0	17.3	100.0

No significant concentration of gold in any particular size fraction was noticed.

GRINDING TESTS

A series of tests were carried out to determine the conditions for grinding the tailing sample to -65; -100; and -200 mesh.

The grinding tests were carried out under the following conditions:

a) Equipment: laboratory ball mill 20 cm diameter x 17 cm length. The grinding ball charge consisting of steel balls weighed 8623 g

b) Feed: 1000 g charge of tailing sample

c) Slurry density: 65% solids

d) Grinding time:

5 minutes for -65 mesh

15 minutes for -100 mesh

35 minutes for - 200 mesh

The sieve analyses of the ground tailing under those conditions are given in Table 5.

Table 5 - Sieve analysis of the ground ore

Size		-65 Mesh			-100 Mesh			-200 Mesh		
Mesh	Microns	% Retained		% Pass	% Retained		% Pass	% Retained		% Pass
		Ind*	Cum.**	Cum.	Ind	Cum.	Cum.	Ind	Cum.	Cum.
65	210	3.0	3.0	97.0	-	-	100.0	-	-	100.0
100	149	10.5	13.5	86.5	1.5	1.5	98.5	-	-	100.0
150	105	14.7	28.2	71.8	7.0	8.5	91.5	1.2	1.2	98.8
200	74	16.2	44.4	55.6	17.7	26.2	73.8	3.5	4.7	95.3
270	53	9.1	53.5	46.5	11.7	37.9	62.1	15.1	19.8	80.2
400	37	14.8	68.3	31.7	18.2	56.1	43.9	16.3	36.1	63.9
- 400		31.7	100.0	-	43.9	100.0	-	63.9	100.0	-
Total		100.0	-	-	100.0	-	-	100.0	-	-

* Individual
** Cumulate

FLOTATION TESTS

Flotation experiments were conducted to recover the gold minerals from the tailing sample.

The investigations aimed to determine the best reagents regime and the optimum grinding for the flotation process.

The results of these investigations are presented below.

A) Determining the Best Reagents Regime

Several tests were carried out to establish the best combination of reagents for optimum gold recovery.

All these tests were performed under -100 mesh grind (73.8% -200 mesh) and natural pH of 6. Few combinations of collectors were used and for each test bulk flotations were carried out under three consecutive additions of reagents. The three concentrates obtained were combined and analysed as a single product. The reagent consumption might appear quite high but at this stage it was intended to determine the maximum possible gold recovery rather than optimize the reagents consumption.

The detailed conditions and results of these tests are presented in Appendix 2.

A summary of the tests results is given in Table 6.

Table 6 - Flotation results using various collectors

Test No.	Reagent		Flotation Concentrate		
	Collector	g/t	% Weight	Assay Au, g/t	% Dist. Au
1	Aerofloat 208	300	6.6	180.1	89.5
2	Aerofloat 208 Xanthate 301	300 150	7.5	166.4	92.7
3	Aerofloat 208 Xanthate 317	300 150	8.4	159.5	93.8
4	Aerofloat 242 Aero 404	300 150	22.3	54.9	94.4
5	Aerofloat 242 Xanthate 317	300 150	25.1	49.3	95.7

The best combination of collectors appeared to be Aerofloat 208 and Aero 317 (sodium isobutyl xanthate) which produced a concentrate of 160 g/t Au for a gold recovery of almost 94% (Test 3).

B) Determining the Optimum Grinding

Flotation tests under various grinding conditions were performed to determine the optimum fineness required by the flotation process.

All the tests were carried out using the same reagents: Aerofloat 208 and Xanthate 317, that produced the best results for gold flotation.

Detailed conditions and results of these tests are presented in Appendix 2.

A summary of the flotation results under various ore finenesses is given in Table 7.

Table 7 - Flotation results at various ore sizes

Test No.	Grind Mesh	Fineness % -200 Mesh	Flot. Concentrate		Flot. Tails Assay Au, g/t	% Recovery in Conc. Au
			% Weight	Assay Au, g/t		
6	Nil	45.7	6.3	177	2.5	82.6
7	- 65	55.6	8.3	144	1.4	90.3
8	- 100	73.8	10.5	130	1.1	93.3
9	- 200	95.3	17.3	96	0.8	96.4

These data indicated that the optimum results were achieved under -100 mesh grind of (70-75% -200 mesh). A coarser grind resulted in a lower gold extraction while a finer grind produced more slimes increasing the concentrate weight at the expense of the gold content.

C) Determining the Required Number of Flotation Stages

One test was performed to determine the required number of flotation stages for achieving optimum gold recovery. The experiment was carried out under the conditions of Test 3, except the concentrates were collected and assayed separately. The results of this test are given in Table 8.

Table 8 - Results of the 3-stage flotation (Test 17)

Product	% Weight		Assay, Au g/t		% Distribution Au	
	Ind*	Cum.**	Ind	Cum.	Ind	Cum.
Conc. - 1	3.0	3.0	452.8	452.8	86.6	86.6
Conc. - 2	2.7	5.7	31.6	253.3	5.4	92.0
Conc. - 3	3.4	9.1	12.3	163.2	2.7	94.7
Tailing	90.9	-	0.91	-	5.3	-
Head	100.0	-	15.7	-	100.0	-

* Individual
**Cumulate

It appeared that the grade of the third stage concentrate was lower than the Au content of the head sample and therefore collecting such a product would dilute the grade of the combined concentrate. However, since in the case of this ore, gold recovery was considered more important than the grade of the concentrate, it was decided to maintain the 3-stage flotation circuit. In continuous operation the second and third concentrate could be recirculated to the flotation feed or subjected to a cleaner scavenger flotation stage from which the cleaner scavenger concentrate would be returned to the feed.

D) Optimum Flotation Conditions and Results

Based on the results of all flotation tests the following optimum conditions were established:

Grinding -100 mesh (70-75% -200 mesh)

Flotation reagents:

Aerofloat 208	300 g/t
Xanthate 317 (Na-isobutyl)	150 g/t
MIBC (methylisobutylcarbinol)	100 g/t
Flotation stages:	3
Flotation time, minutes:	8.5
pH: natural	6.1

Under these conditions the following results were obtained (Table 9).

Table 9 - Optimum flotation results

Product	% Weight	Assay			% Distribution		
		Au, g/t	Ag, g/t	S%	Au	Ag	S
Head	100.0	14.3	1.0	0.04	100.0	100.0	100.0
Flot. Conc.	8.4	159.5	6.0	0.41	93.8	51.9	78.9
Flot. Tails	91.6	1.0	0.5	0.01	6.2	48.1	21.1

CYANIDATION TESTS

Cyanidation tests, using the open bottle procedure were conducted to evaluate the possibility of gold extraction from the tailing sample.

Two parameters were investigated: the cyanidation time and the ore fineness. All the tests were run using 1 g/L NaCN concentration and pH $>$ 11.0. The oxygen content of the solution was not controlled at this time.

A) Determining the Optimum Cyanidation Time

A series of cyanidation tests were carried out where contact time varied between 6-48 hours. Some of the tests were run in duplicate to confirm the results. All the experiments were performed under -100 mesh grinding conditions.

Detailed conditions and results of the cyanidation tests are given in Appendix 3.

A summary of the results showing the influence of the cyanidation time is presented in Table 10.

Table 10 - Cyanidation results at various contact times

Test No	Contact time hrs	Assay, Au g/t		% Au Rec in Cyanide Sol'n	Reagents Consumption kg/t	
		Head (calc)	Residue (assay)		NaCN	CaO
103	6	12.8	1.40	89.1	0.3	4.06
104	12	14.1	0.74	94.7	0.4	4.14
101	24	12.3	0.53	95.7	0.9	5.72
105	24	13.3	0.41	96.9	0.5	4.20
102	48	13.5	0.41	97.0	0.9	5.72
106	48	13.3	0.51	96.2	0.6	4.22

The results of these tests indicated that the optimum cyanidation time is 24 hours, which gave a gold extraction of approximately 96%. Twelve and six hours contact time resulted in cyanide residue of higher gold content while 48 hours time gave no significant gain in gold recovery. The cyanide consumption for 24 hours contact time was approximately 500 g/t of ore.

B) Determining the Optimum Ore Fineness

Several tests were carried out to determine the optimum ore fineness for the cyanidation of the tailing sample. The tests were performed with unground material as well as using sample charges ground to -65, -100 and -200 mesh. For all the tests a cyanidation time of 24 hours was employed.

Detailed conditions and results of the tests are given in Appendix 3.

A summary of the cyanidation results under various ore finenesses is presented in Table 11.

Table 11 - Cyanidation results at various ore sizes

Test No	Grind Mesh	Fineness % -200 mesh	Assay, Au g/t		% Au Recovered in Cyanide Sol'n	Reagents Consumption kg/t	
			Head (calc)	Residue (assay)		NaCN	CaO
107	Nil	45.7	13.8	2.9	79.1	0.3	3.5
108	- 65	55.6	11.4	0.93	91.8	0.5	3.5
109	-100	73.8	12.9	0.55	95.7	0.3	4.1
110	-200	95.3	12.2	0.38	96.9	0.8	4.2

These tests indicated that the optimum cyanidation results were obtained under -100 mesh grinding conditions, where the gold recovery reached approximately 96% with a cyanide consumption of 300 g/t. At a coarser grind the gold recovery dropped to about 92%, while under -200 mesh grinding (95.3% -200 mesh) the increase in the gold extraction was not significant.

C) Optimum Conditions and Results (Cyanidation)

Based on the cyanidation results the following optimum conditions were estblished:

Grinding: -100 mesh (70-75% -200 mesh)

Cyanidation:

Slurry density	33% solids
Protective alkali	by lime, pH 11.0
Solution concentration	1 g/L NaCN
Contact time	24 hours

Table 12 gives the results obtained under these conditions (average data of Tests 101, 105 and 109).

Table 12 - Optimum cyanidation results

Product	Assay Au		% Dist. Au	Reagents Consumption kg/t	
	mg/L	g/t		NaCN	CaO
Cyanide Sol'n	6.3		72.8	0.6	4.7
Wash Sol'n	1.6		22.9		
Residue		0.5	4.3		
Head (calc.)		12.8	100.0		

FLOTATION FOLLOWED BY THE CYANIDATION OF THE FLOTATION CONCENTRATE

Since both flotation and direct cyanidation of the tailing sample resulted in high gold recoveries, it was considered appropriate to investigate the possibility of gold extraction by a combination of these two technologies, namely: flotation followed by the cyanidation of the flotation concentrate.

The combined process presents the following advantages versus the individual technologies: Cyanidation of the flotation concentrate rather than that of the entire ore will result in a significant cost reduction for the cyanidation process because only a small fraction of the plant feed will undergo cyanide leaching. Also cyanide leaching will provide a gold precipitate of much higher concentration in precious metals than that of the flotation product.

Flotation of the tailing sample to produce the required quantity of concentrate for the cyanidation tests was carried out using the optimum conditions (Test 3).

The flotation concentrate was subjected to cyanide leaching for a duration of 24 and 48 hours.

Four tests were performed. Detailed conditions and results of these tests are given in Appendix 4 while Table 13 summarizes the metallurgical data.

The flotation concentrates assayed between approximately 100 and 130 g/t Au for a gold recovery of about 92%.

Cyanidation of the flotation concentrates was performed using the open bottle procedure. In most of the cases the concentrate filter cakes were subjected to a short homogenization process, in a ball mill, prior to cyanide leaching. The purpose of this action was to homogenize the cyanidation feed in preparation for leaching since each cyanidation experiment was carried out on a composite of concentrates obtained from 5 flotation tests. This homogenization process should not be considered as a regrinding stage and is definitely not required in pilot or industrial application. It was believed that there was no need to create better liberation for the gold particles in the flotation concentrate, prior to cyanidation, since the concentrate fineness, in the as-produced state, was 94% -400 mesh, although the ore subjected to flotation was ground to 73.8% -200 mesh. The sieve analysis of the concentrate before and after the homogenization stage showed no significant change in the size distribution

Table 13 - Results of flotation and concentrate cyanidation

Test No	Flotation				Concentrate Cyanidation						Combined Processes			
	Concentrate			Tails Assay Au,g/t	Contact time h	Assay Au, g/t		% Au Rec. in Sol'n	Reagents Consumption kg/t of conc.		% Au Rec. o/A	Assay Au, g/t Total Tails	Reagents Consumption kg/t of ore	
	% Weight	Assay Au, g/t	% Dist. Au			Head	Residue		NaCN	CaO			NaCN	CaO
10/111	9.5	132.0	92.0	1.2	24	109.9	30.2	72.5	1.6	11.6	66.7	4.0	0.152	1.102
16/116a	8.5	125.1	91.4	1.1	24	125.1	30.9	75.3	2.9	10.9	68.8	3.6	0.247	0.927
15/112	12.0	97.7	92.4	1.1	48	84.7	1.3	98.5	3.1	10.9	91.0	1.1	0.368	1.303
16/116b	8.5	125.1	91.4	1.1	48	125.1	4.8	96.2	3.3	16.0	88.0	1.4	0.281	1.360

above 400 mesh screen (4.4% for the homogenized concentrate as compared with 6% for the concentrate as produced). The size distribution of the two products in the subsieve range might have been a little more different but it was not determined.

The results of the cyanidation experiments indicated that under the laboratory testing conditions a contact time of up to 48 hours was required to obtain a gold recovery in the cyanide solution in range of 96-98%, related to the cyanidation feed. In pilot or industrial application, under mechanical agitation and intense aeration the cyanidation time could probably be reduced to some extent.

ACKNOWLEDGEMENT

Grateful acknowledgement is extended to Chemical Laboratory, particularly the Ores and Fire Assay Section headed by J.C. Hole for their important contribution to this project by carrying out a large volume of analyses and providing highly accurate results.

Appendix 1
Mineralogical Report

MINERAL PROCESSING LABORATORY

MINERALOGY SECTION

Report M - 3220

TITLE: Mineralogical and electron microprobe studies of a head sample of gold tailings from the Lake Charlotte Mine, Nova Scotia.

PROJECT NO.: 3.3.0.0.0.4 "Precious Metals Recovery from Ores, Tailings & Residues".

SAMPLE: Three products resulting from heavy liquid separations on a head sample of gold tailings from the Lake Charlotte Mine, N.S., were received from R.M. Buchanan on August 31, 1981. Three polished sections which had been prepared from the heavy liquid separation products were also received and were labelled "Float 2.96, Float 3.30 and Sink 3.30". Mr. Buchanan stated that the head sample had originally been received from Mr. M.A. Cristovici of this laboratory. The weight percentages of the products are given in Table 1.

TABLE 1

Weight percentages of the heavy liquid separation products

Product	wt.%
Float 2.96	92.1
Float 3.30	7.4
Sink 3.30	0.5
	100.0

PURPOSE: To determine the mineralogy of the heavy minerals in the products with particular reference to the occurrence of gold (12 g/t) and silver.

METHOD OF INVESTIGATION: The polished sections were examined under the ore microscope to identify the ore minerals and to select grains for microprobe analysis or for further study under the scanning electron microscope. Powder X-ray diffraction analyses were made on several minerals to confirm their identity.

RESULTS: The ore minerals in the separation products consist, chiefly, of goethite, arsenopyrite and ilmenite with lesser amounts of pyrite and from small to trace amounts of scheelite ($CaWO_4$), chalcopyrite, hematite, rutile, magnetite, pyrrhotite, loellingite, native gold, native bismuth, maldonite?(Bi_2Au), bismite?(Bi_2O_3), and calomel?(Hg_2Cl_2). The sink-product at specific gravity 3.30 also contains several small fragments of oxidized copper wire and a flocculent ball of minute grains of pyrite, chalcopyrite and sphalerite.

The ore minerals show that the tailings has been subjected to prolonged oxidation because nearly every visible grain of arsenopyrite and pyrite in polished section has been partly replaced by arsenates (scorodite) and hydroxides (goethite), respectively.

Gold

Neither native gold nor gold-bearing minerals were observed in the polished section of the float-product (sp gr. 2.96). However, native gold was observed in the second float-product (sp gr 3.30) as several apparently liberated grains (10 to 25 micrometers in size*) and in two instances as inclusions in siliceaous gangue minerals. The first occurrence involved a single inclusion of native gold (15 μm) and the second revealed numerous minute inclusions

.../2

Approved _____ Signed D. R. Owens Date Sept. 26/81

Section Head — Mineralogy Section

Copies to: 1. R.M. Buchanan 2. M.A. Cristovici 3. D. Owens

4. M.P.L. Files 5. Section Files

(1 to 20 μm) in a two-phase silicate host (Fig. 1). As expected, the sink-product (sp gr 3.30) was the richest in gold and the most diverse in its mineralogy. The native gold occurred, essentially, as inclusions in single and multi-silicate grains (Figs. 2, 3, 4 & 5) as apparently liberated grains (Figs. 6 & 7) and to a much lesser degree as inclusions in arsenopyite (Fig. 9) and its alteration product. The inclusions and liberated grains range in size from less than 1 to approximately 90 and from 10 to 180 micrometers, respectively.

The native gold exhibits two different textures. Although a few of the liberated grains are solid (Fig. 7) most have a spongy appearance, whereas the reverse is true for the inclusions.

Quantitative microprobe analyses showed that the gold in the products contains between 1.8 and 4.8 weight per cent silver. In addition, the majority, but not all, of the liberated grains contain significant amounts of mercury. Average mercury contents of 6.4 (Fig. 6), 16.2, 23.8 and 37.0 (Fig. 7) weight per cent Hg were detected from four out of six randomly selected grains. The electron microprobe analysis of the grain with the highest detected mercury content (Fig. 7) showed it to be extremely inhomogeneous with mercury contents as high as 45.0 wt% (Table 2). The composition of the native gold occurring as inclusions in both the silicates and arsenides is different than that of the liberated grains, in that none of those that were analysed (minimum size analysed was 8 micrometers) contained detectable amounts of mercury. The usual silver values were present. Eventhough the smallest of the native gold inclusions could not be assessed for their mercury or silver contents, there is no valid reason to think that their composition would be different than the larger inclusions.

One other grain of gold with a different composition and mineralogical association was observed in the sink-product (sp gr 3.30). It differed from the other grains of gold in that neither silver nor mercury were present in detectable amounts and it contained several different types of inclusions (Fig. 9). These included several grains of maldonite? (Au_2Bi) a grain of bismite?(Bi_2O_3) as well as several adhering particles of native bismuth. X-ray micrographs of this complex grain have been included to show the areas of concentration for Au and Bi (Figs. 10 and 11). The identification of bismite is based on two criteria. First, the bismite? has a lower average atomic number than the native Bi (Fig. 9) and second, no other elements other than Bi were detected by E.D.X. analysis. The identification of the maldonite?(Au_2Bi) is based on an electron microprobe analysis (Table 3). Although the atomic proportions for Au are slightly high, it is reasonably close to 2:1.

One other unusual mineral was found in the sink-product (sp gr 3.30). It occurs as several small grains partly adhering to the Hg-rich gold shown in Figure 7. It is a mercury chloride and is probably calomel (Hg_2Cl_2).

---

* The term "size" as used in this report refers to the greatest dimension of the mineral grain being described.

TABLE 2

Microprobe analysis of Hg-rich gold

Average composition		Range
Element	wt%	wt%
Au	60.9	53.0 to 66.3
Hg	37.0	31.8 to 45.0
Ag	2.3	1.8 to 3.1
	100.2	

TABLE 3

Microprobe analysis of maldonite?

Element	wt%	mol
Au	68.3	.347
Bi	33.2	.159
	101.7	

CONCLUSIONS

The completed examination of the products prepared from the head sample of the tailing allows the following conclusions to be made.

(1) The tailings contain a number of large grains of gold of sufficient size and liberation to be recovered by gravity methods or by cyanidation.

(2) The tailings also contain a large amount of native gold as small to minute inclusions completely enclosed in a diverse group of silicates and to a much lesser extent as inclusions in arsenopyrite and its alteration product. These are not directly accessible to cyanidation.

(3) The presence of mercury in many of the liberated grains and its apparent absence in the inclusions indicates that the liberated grains must have come in contact with mercury which probably was used in the initial recovery procedures, but with insufficient contact for their immediate recovery.

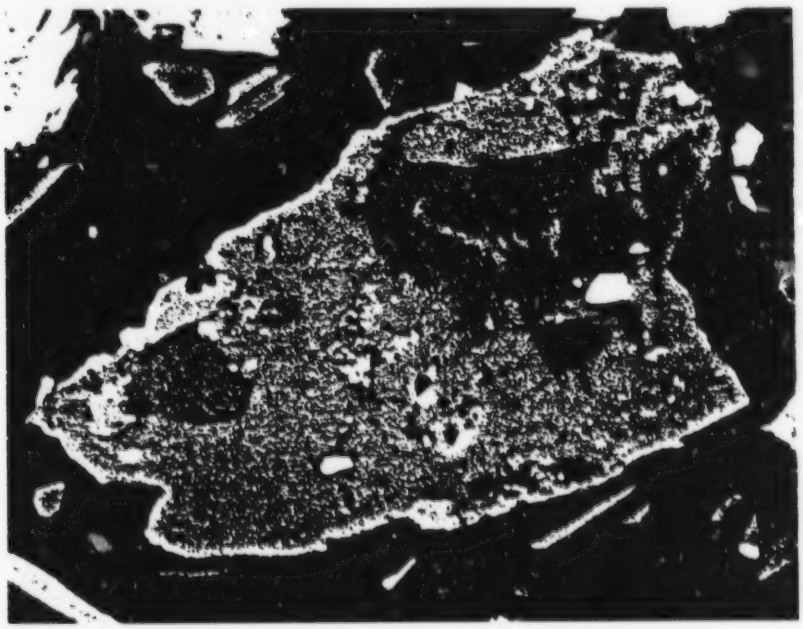


Figure 1. Back-scattered electron micrograph of a polished section(Float 3.30) showing minute inclusions of native gold (white) in a combined grain of feldspar(dark grey) and Ca(Fe)Al silicate (medium grey). The large black areas surrounding the silicates or ore minerals in this and in the following micrographs represents the mounting medium of the polished sections.

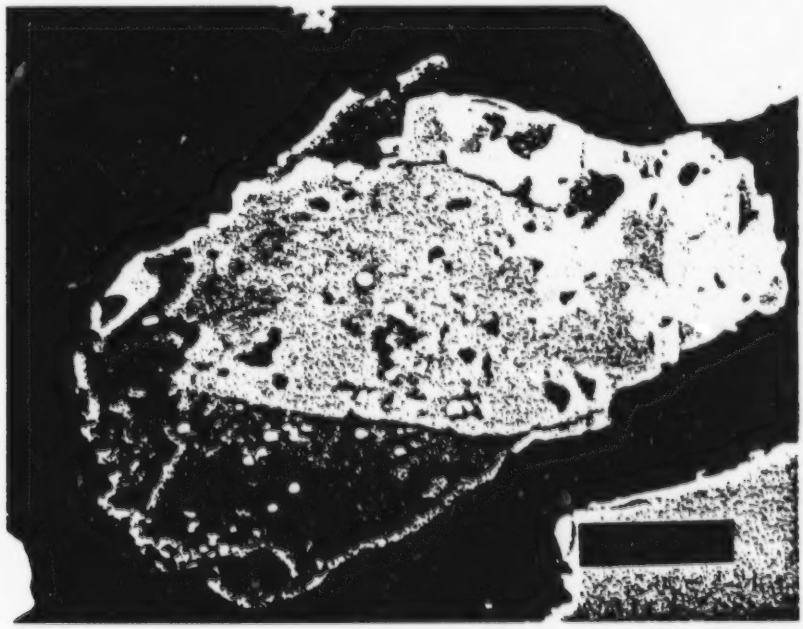


Figure 2.Back-scattered electron micrograph of a polished section(Sink 3.30) showing minute inclusions of native gold(white) in a complex grain of orthoclase feldspar(dark grey),pyroxene?(medium grey,[CaFe(Mg,Al,Mn)Si]) and sphene (light grey).

Figure 3. Back-scattered electron micrograph of a polished section (Sink 3.30) showing small inclusions of gold (white) in a mono-silicate host of pyroxene? [CaFe(Mg,Mn)Si].

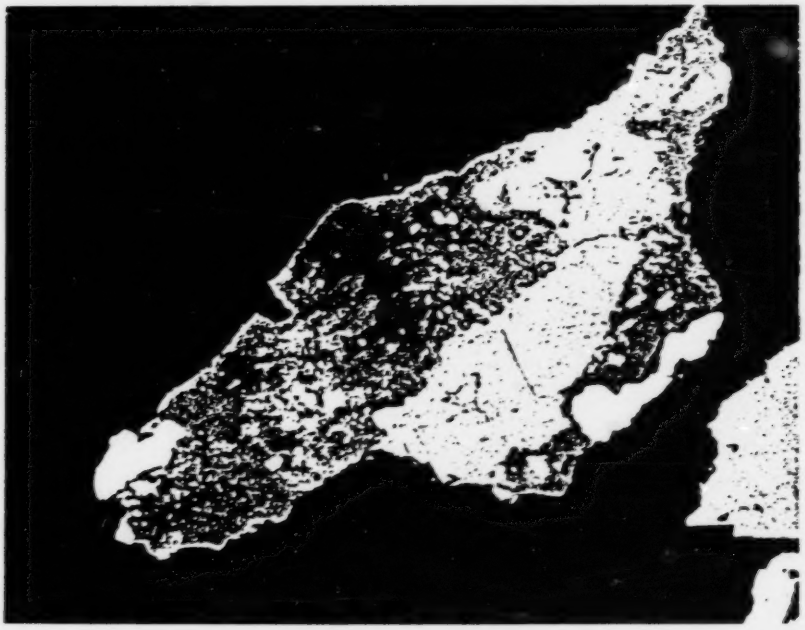


Figure 4. Back-scattered electron micrograph of a polished section (Sink 3.30) showing numerous small to almost sub-micrometer inclusions of gold (white) in a multi-silicate grain of quartz (dark grey), CaAl silicate (medium grey) and pyroxene?[medium grey,Ca,Fe(Mg,Mn)Si].

Figure 5. X-ray micrograph for AuLα + AuMα of the multi-silicate grain in Figure 4 showing that even the smallest inclusions are gold. The gold is defined by concentrations of white dots. The widely scattered dots are background.

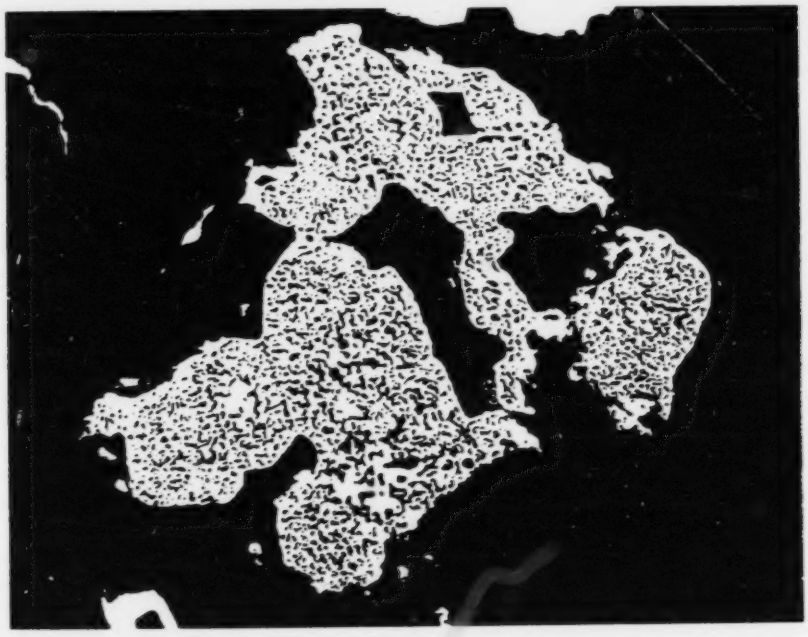


Figure 6. Back-scattered electron micrograph of a polished section (Sink 3.30) showing a large and apparently liberated grain of spongy-textured, Hg-bearing gold.

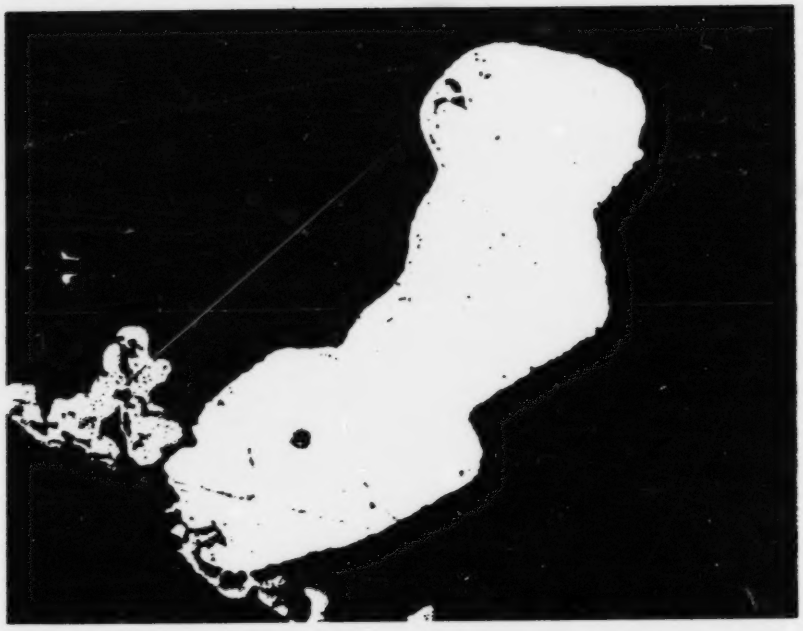


Figure 7. Back-scattered electron micrograph of a polished section (Sink 3.30) showing a solid grain of gold (white) with the highest mercury content detected(Table 2). The small particles (light grey) partly adhering to the gold are probably calomel.

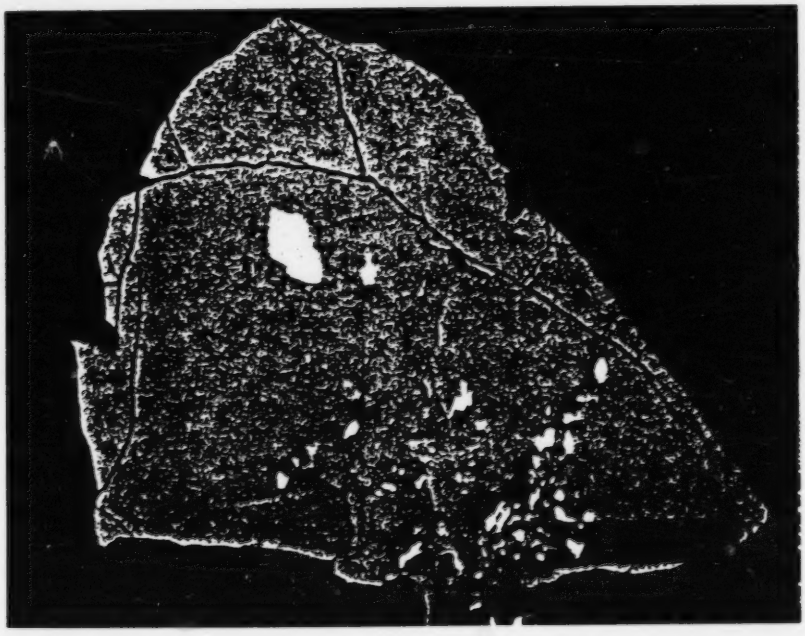


Figure 8. Back-scattered electron micrograph of a polished section (Sink 3.30) showing a grain of arsenopyrite (medium grey) containing a number of minute inclusions of gold (white) and several of loellingite (Light grey).

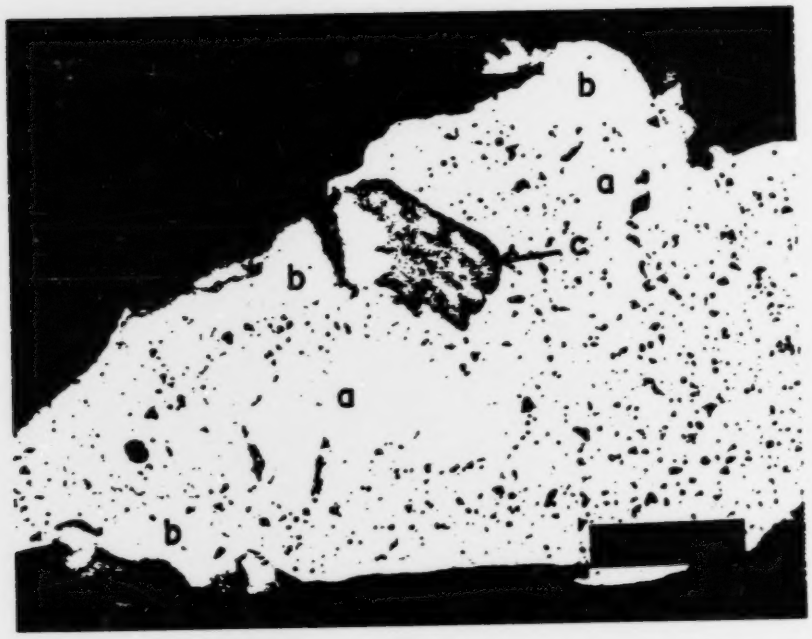


Figure 9. Back-scattered electron micrograph of a polished section (Sink 3.30) showing a grain of gold (greyish white, pitted) containing inclusions of maldonite? (a), bismite(c) and adhering particles of native bismuth (b).

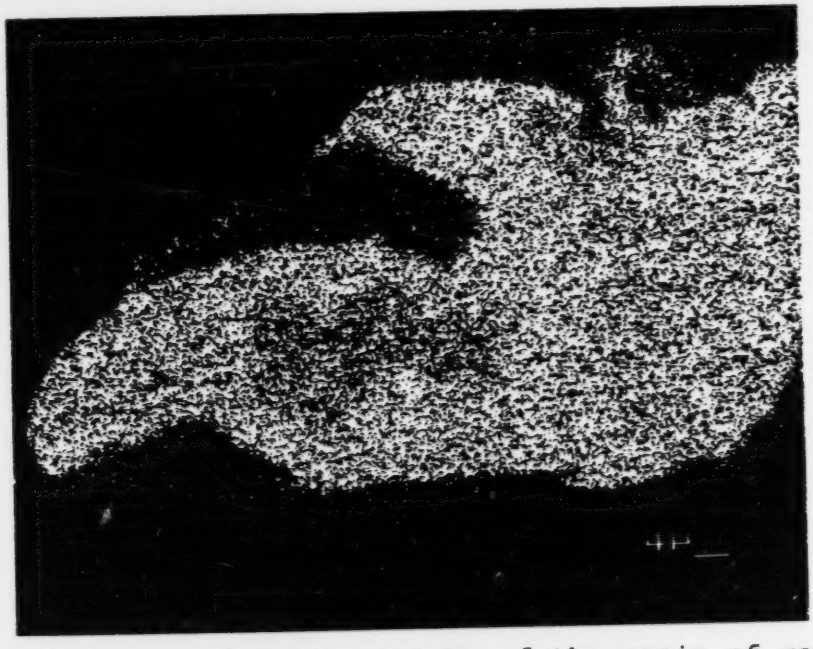


Figure 10. X-ray micrograph for AuLα + AuMα of the grain of gold in Figure 9. The intensity of the white dots is a function of the gold content. The widely scattered dots represent background.

Figure 11. X-ray micrograph for BiLα + BiMα of the grain of gold in Figure 9. The intenstity of the white dots is a function of the bismuth content. Because of its high atomic number, the native gold shows a higher background than the surrouning mounting medium of the polished section.

Appendix 2

Flotation Tests 1-9, 17

Conditions and Results

FLOTATION TEST REPORT

SAMPLE :

WEIGHT-GR. : 1000

TEST NO.: 1

DATE:

OBJECT OF TEST: Determining best reagent regime

TEST BY:

OPERATION	Time Min.	% Solids	pH	Unit	Reagents - g/t 208	MIBC	GRIND Mesh Size	GRIND Wt%
Grinding	15	65					-200	73.8
Conditioning	3	25	6.1		100			
"	1					52		
Flot.Ro.Conc-1	4							
Conditioning	3				100	26		
Flot.Ro.Conc-2	2 1/2							
Conditioning	3				100	26		
Flot.Ro.Conc-3	2							

PRODUCT	Wt. GR.	Wt. %	ASSAYS g/t Au	METAL CONTENT	DISTRIBUTION Au
Combined Conc.1-3		6.6	180.1		89.5
Tailing		93.4	1.49		10.5
Head (Calc.)		100.0	13.3		00.0

FLOTATION TEST REPORT

TEST NO.: 2

WEIGHT-GR.: 1000

DATE:

SAMPLE:

TEST BY:

OBJECT OF TEST: Determining best reagent regime

OPERATION	Time Min.	% Solids	pH	Unit	Reagents - g/t 208	301	MIBC
Grinding	15	65					
Conditioning	3	25	6.1		100	50	
"	1						52
Flot Ro-Conc-1	4						
Conditioning	3				100	50	
"	1						27
Flot.RoConc-2	3						
Conditioning	3				100	50	
"	1						27
Flot.RoConc-3	2						

GRIND Mesh Size	Wt %
-200	73.8

PRODUCT	Wt. GR.	Wt. %	ASSAYS Au	METAL CONTENT	DISTRIBUTION Au
Comb.Conc 1-3		7.5	166.4		92.7
Tailing		92.5	1.06		7.3
Head (calc.)		100.0	13.5		100.0

FLOTATION TEST REPORT

SAMPLE :

WEIGHT - GR. : 1000

TEST NO.: 3

DATE:

OBJECT OF TEST: Determining best reagent regime

TEST BY:

OPERATION	Time Min.	% Solids	pH	Unit	Reagents · g/t 208	317	MIBC	GRIND Mesh Size	Wt %
Grinding	15	65						-200	73.8
Conditioning	3	25	6.1		100	50			
"	1						52		
Flot.Ro-Conc-1	3 1/2								
Conditioning	3				100	50			
"	1						27		
Flot.RoConc-2	3								
Conditioning	3				100	50			
"	1						27		
Flot.RoConc-3	2								

PRODUCT	Wt. GR.	Wt. %	ASSAYS g/t Au	Ag	S %	METAL CONTENT	DISTRIBUTION Au	Ag	S
Combined Conc.		8.4	159.5	6.0	0.41		93.8	51.9	78.9
Tailing		91.6	0.97	0.51	0.01		6.2	48.1	21.1
Head (calc.)		100.0	14.3	1.0	0.04		100.0	100.0	100.0

FLOTATION TEST REPORT

SAMPLE:

WEIGHT - GR.: 1000

TEST NO.: 4

DATE:

OBJECT OF TEST: Determining best reagent regime

TEST BY:

OPERATION	Time Min.	% Solids	pH	Unit	Reagents - g/t 242	404	MIBC
Grinding	15	65					
Conditioning	3	25	6.1		100	50	
"	1						52
Rougher Conc-1	3 1/2						
Conditioning	3				100	50	
"	1						27
Rougher Conc-2	3						
Conditioning	3				100	50	
"	1						27
Rougher Conc-3	2						

GRIND

Mesh Size	Wt %
-200	73.8

PRODUCT	Wt. GR.	Wt. %	ASSAYS g/t Au	METAL CONTENT	DISTRIBUTION - % Au
Conc #1		5.1	196.2		77.2
#2		10.6	15.1		12.3
#3		6.6	9.6		4.9
Rougher Tail		77.7	0.93		5.6
Head (calc.)		100.0	13.0		00.0
Comb. Conc 1 & 2		15.7	73.9		89.5
" " 1&2&3		22.3	54.9		94.4

FLOTATION TEST REPORT

SAMPLE :

WEIGHT - GR. : 1000

TEST NO.: 5

DATE:

OBJECT OF TEST: Determining best reagent regime

TEST BY:

OPERATION	Time Min.	% Solids	pH	Unit	Reagents - g/t 242	317	MIBC	GRIND Mesh Size	GRIND Wt%
Grinding	15	65						-200	73.8
Conditioning	3	25	6.1		100	50			
"	1						52		
Rougher Conc-1	3 1/2								
Conditioning	3				100	50			
"	1						27		
Rougher Conc-2	3								
Conditioning	3				100	50			
"	1						27		
Rougher Conc-3	2								

PRODUCT	Wt. GR.	Wt. %	ASSAYS g/t Au	METAL CONTENT	DISTRIBUTION Au
Conc #1	77.9	7.8	141.3		85.2
#2	102.6	10.3	10.3		8.2
#3	70.2	7.0	4.3		2.3
Rougher Tail	747.9	74.9	0.74		4.3
Feed(calc.)	998.6	100.0	12.9		100.0
Comb.Conc 1&2		18.1	66.8		93.4
" " 1&2&3		25.1	49.3		95.7

FLOTATION TEST REPORT

WEIGHT-GR.: 1000

TEST NO.: 6

DATE:

TEST BY:

SAMPLE:

OBJECT OF TEST: Determining optimum grinding (No grind)

OPERATION	Time Min.	% Solids	pH	Unit	Reagents - g/t 208	Z-14	MIBC
Conditioning	3	25			100	50	52
"	1						
Flot.RoConc-1	3 1/2		5.9				
Conditioning	3				100	50	27
"	1						
Flot.RoConc-2	3						
Conditioning	3				100	50	27
"	1						
Flot Ro Conc-3	2						

GRIND

Mesh Size	Wt%
-200	45.7

PRODUCT	Wt. GR.	Wt. %	ASSAYS g/t Au	METAL CONTENT	DISTRIBUTION % Au
Combined Conc 1-3		6.3	177.0		82.6
Tailing		93.7	2.5		17.4
Head (calc.)		100.0	13.5		100.0

FLOTATION TEST REPORT

SAMPLE:

WEIGHT-GR.: 1000

OBJECT OF TEST: Determining optimum grinding (-65 mesh grind)

TEST NO.: 7

DATE:

TEST BY:

OPERATION	Time Min.	% Solids	pH	Unit		RPM	Reagents - g/t 208	Z-14	MIBC	GRIND Mesh Size	GRIND Wt%
Grinding	5	65									
Conditioning	3	25	6.1			2000	100	50		-200	55.6
"	1								52		
Flot.RoConc-1	3 1/2										
Conditioning	3						100	50			
"	1								27		
Flot.RoConc-2	3										
Conditioning	3						100	50			
"	1								27		
Flot.RoConc-3	2										

PRODUCT	Wt. GR.	Wt. %	ASSAYS g/t Au	METAL CONTENT	DISTRIBUTION - Au
Comb.Conc 1-3		8.3	144.0		90.3
Tailing		91.7	1.4		9.7
Head (calc.)		100.0	13.2		100.0

FLOTATION TEST REPORT

SAMPLE :

WEIGHT-GR. : 1000

TEST NO.: 8

DATE:

OBJECT OF TEST: Determining optimum grinding (-100 mesh grind)

TEST BY:

OPERATION	Time Min.	% Solids	pH	Unit	Reagents - g/t 208	Z-14	MIBC
Grinding	15	65					
Conditioning	3	25	6.1		100	50	
"	1						52
Flot.RoConc-1	3 1/2						
Conditioning	3				100	50	
"	1						27
Flot. RoConc-2	3						
Conditioning	3				100	50	
"	1						27
Flot.RoConc-3	2						

GRIND Mesh Size	Wt%
-200	73.8

PRODUCT	Wt. GR.	Wt. %	ASSAYS g/t Au	METAL CONTENT	DISTRIBUTION % Au
Comb.Conc 1-3		10.5	130.0		93.3
Tailing		89.5	1.1		6.7
Head (calc.)		100.0	14.6		100.0

FLOTATION TEST REPORT

SAMPLE :

WEIGHT - GR. : 1000

TEST NO.: 9

OBJECT OF TEST: Determining optimum grinding (-200 mesh grind)

DATE:

TEST BY:

OPERATION	Time Min.	% Solids	pH	Unit	Reagents - g/t 208	Z-14	MIBC
Grinding	35	65					
Conditioning	3	25	6.1		100	50	
"	1						52
Flot.RoConc-1	3 1/2						
Conditioning	3				100	50	
"	1						27
Flot.RoCoud-2	3						
Conditioning	3				100	50	
"	1						27
Flot.RoConc-3	2						

GRIND Mesh Size	Wt %
-200	95.3

PRODUCT	Wt. GR.	Wt. %	ASSAYS g/t Au	METAL CONTENT	DISTRIBUTION % Au
Comb. Conc 1-3		17.3	96.0		96.4
Tailing		82.7	0.75		3.6
Head (calc.)		100.0	17.2		100.0

FLOTATION TEST REPORT

SAMPLE :

WEIGHT-GR. : 2 x 1000

TEST NO.: 17

OBJECT OF TEST: Determining the number of flotation stages

DATE:

TEST BY:

OPERATION	Time Min.	% Solids	pH	Unit	Reagents - g/t 208	Z-14	MIBC	GRIND Mesh Size	GRIND Wt%
Grinding	15	65						-200	73.8
Conditioning	3	25	6.1		100	50			
"	1						52		
Flot.RoConc-1	3 1/2								
Conditioning	3				100	50			
"	1						27		
Flot.RoConc-2	3								
Conditioning	3				100	50			
"	1						27		
Flot.RoConc-3	2								

PRODUCT	Wt. GR.	Wt. %	ASSAYS g/t Au	METAL CONTENT	DISTRIBUTION - % Au
Concentrate -1		3.0	452.8		86.6
" -2		2.7	31.6		5.4
" -3		3.4	12.3		2.7
Tailing		90.9	0.91		5.3
Head (calc.)		100.0	15.7		100.0
Comb.Conc 1&2		5.7	253.3		92.0
" " 1&2&3		9.1	163.2		94.7
Conc. 3+Tailing		94.3	1.3		8.0

Appendix 3

Cyanidation Tests 101-110

Conditions and Results

TEST NUMBER 101

CYANIDATION TEST RECORD

Object of Test: Determining optimum cyanidation time

Feed: 500 g;

Sol'n Vol. 1000 ml

Hours 24

Sol'n Conc. 1.0 g/ℓ NaCN

Pulp Density: 33 % solids

Fineness: -100 mesh (15',65% solids, 73.8% - 200 mesh

Regents Balance _____

Time Cumul. hrs	ADDED GRAMS ACTUAL NaCN	ADDED GRAMS ACTUAL $Ca(OH)_2$	ADDED GRAMS EQUIVALENT NaCN	ADDED GRAMS EQUIVALENT CaO	RESIDUAL g NaCN	RESIDUAL g CaO	CONSUMED g NaCN	CONSUMED g CaO	PH
	--	--	--	--	--	--	--	--	6.2
	--	3.00	--	2.19	--	--	--	--	11.6
Start	1.03	--	1.00		--	--	--	--	--
2.0		--	1.00	--	0.55	0.02	0.45	2.17	10.5
	0.46	1.00	0.45	0.73	--	--	--	--	12.0
6	Nil	Nil	Nil	Nil	1.00	0.14	Nil	0.61	11.8
12.0	Nil	Nil	Nil	Nil	1.00	0.06	Nil	0.08	11.6
24.0	Nil	Nil	Nil	Nil	1.00	0.06	Nil	Nil	11.4
Total	1.49	4.00	1.45	2.92	1.00	0.06	0.45	2.86	

Cyanide sol'n: 735 ml
Wash sol'n: 1015 ml
Residue: 518.7 g

Reagents Consumption: Kg/t

NaCN: 0.900
CaO: 5.720

CYANIDATION TEST RESULTS

SAMPLE:

OBJECT OF TEST:

WEIGHT - GR.:

TEST NO.: 101

DATE:

TEST BY:

OPERATION	Time Min.	% Solids	pH	Unit			Reagents - lbs/ton												GRIND Size	GRIND Wt %

PRODUCT	Wt. GR Amount	Wt. %	ASSAYS g/t or mg/l Au	METAL CONTENT	DISTRIBUTION % Au
Cyanide Sol'n	735	ml	6.2		71.7
Water	1015	ml	1.5		24.0
Residue	518.7	g	0.53		4.3
Head (calc.)			12.3		100.0

CYANIDATION TEST RECORD

TEST NUMBER 102

Object of Test: Determining optimum cyanidation time

Sol'n Conc. 1.0 g/ℓ NaCN

Feed: 500 g;

Pulp Density: 33 % solids

Sol'n Vol. 1000 ml

Fineness: -100 mesh (15',65% solids, 73.8% - 200 mesh

Hours 48

Regents Balance

Time Cumul. hrs	ADDED GRAMS ACTUAL NaCN	ADDED GRAMS ACTUAL $Ca(OH)_2$	ADDED GRAMS EQUIVALENT NaCN	ADDED GRAMS EQUIVALENT CaO	RESIDUAL g NaCN	RESIDUAL g CaO	CONSUMED g NaCN	CONSUMED g CaO	PH
	--	--	--	--	--	--	--	--	6.2
	--	3.00	--	2.19	--	--	--	--	11.6
Start	1.03	--	1.00	--	--	--	--	--	--
2.0	--	--	--	--	0.55	0.02	0.45	2.17	10.5
	0.46	1.00	0.45	0.73	--	--	--	--	12.0
6.0	Nil	Nil	Nil	Nil	1.00	0.14	Nil	0.61	11.8
12.0	Nil	Nil	Nil	Nil	1.00	0.06	Nil	0.08	11.6
24.0	Nil	Nil	Nil	Nil	1.00	0.06	Nil	Nil	11.4
30.0	Nil	Nil	Nil	Nil	1.00	0.06	Nil	Nil	11.4
36.0	Nil	Nil	Nil	Nil	1.00	0.06	Nil	Nil	11.4
48.0	Nil	Nil	Nil	Nil	1.00	0.06	Nil	Nil	11.4
Total	1.49	4.00	1.45	2.92	1.00	0.06	0.45	2.86	

Cyanide sol'n: 750 ml
Wash sol'n: 1030 ml
Residue: 480.4 g

Reagents Consumption: Kg/t

NaCN: 0.900
CaO: 5.720

CYANIDATION TEST RESULTS

SAMPLE :

WEIGHT - GR. :

TEST NO.: 102

OBJECT OF TEST:

DATE:

TEST BY:

OPERATION	Time Min.	% Solids	pH	Unit			Reagents - lbs/ton											GRIND Size	GRIND Wt%

PRODUCT	Wt. GR Amount	Wt. %	ASSAYS g/t or mg/l Au	METAL CONTENT	DISTRIBUTION % Au
Cyanide Sol'n	750	ml	6.2		71.6
Wash "	1030	ml	1.6		25.4
Residue	480.4	g	0.41		3.0
Head (calc.)			13.5		100.0

TEST NUMBER 103

CYANIDATION TEST RECORD

Object of Test: Determining optimum cyanidation time

Feed: 500 g;

Sol'n Vol. 1000ml

Hours 6

Sol'n Conc. 1.0 g/ℓ NaCN

Pulp Density: 33 % solids

Fineness: -100 mesh (15',65% solids, 73% - 200 mesh

Regents Balance _____

Time Cumul. hrs	ADDED GRAMS ACTUAL NaCN	ADDED GRAMS ACTUAL $Ca(OH)_2$	ADDED GRAMS EQUIVALENT NaCN	ADDED GRAMS EQUIVALENT CaO	RESIDUAL g NaCN	RESIDUAL g CaO	CONSUMED g NaCN	CONSUMED g CaO	PH
	--	--	--	--	--	--	--	--	6.3
	--	3.00	--	2.19	--	--	--	--	11.9
Start	1.05	--	1.00	--	--	--	--	--	--
2	0.11	--	0.10	--	.90	.22	0.10	1.97	11.9
6	Nil	Nil	Nil	Nil	.95	.16	0.05	.06	11.8
Total	1.16	3.00	1.10	2.19	0.95	0.16	0.15	2.03	

Cyanide sol'n: 780 ml
Wash sol'n: 1000 ml
Residue: 494.8 g

Reagents Consumption: Kg/t

NaCN: 0.30
CaO: 4.06

CYANIDATION TEST RESULTS

SAMPLE :

WEIGHT - GR. :

TEST NO.: 103

OBJECT OF TEST:

DATE:

TEST BY:

OPERATION	Time Min.	% Solids	pH	Unit			Reagents - lbs/ton												GRIND Size	GRIND Wt%

PRODUCT	Wt. GR Amount	Wt. %	ASSAYS g/t or mg/l Au	METAL CONTENT	DISTRIBUTION % Au
Cyanide Sol'n	780	ml	5.7		70.2
Wash "	1000	ml	1.2		18.9
Residue	494.8	g	1.4		10.9
Head (calc.)			12.8		100.0

TEST NUMBER 104

CYANIDATION TEST RECORD

Object of Test: Determining optimum cyanidation time

Sol'n Conc. 1.0 g/ℓ NaCN

Feed: 500 g;

Pulp Density: 33 % solids

Sol'n Vol. 1000 ml

Fineness: 15' 65% solids, 73.8% - 200 mesh

Hours 12

Regents Balance

Time Cumul. hrs	ADDED GRAMS ACTUAL NaCN	ADDED GRAMS ACTUAL $Ca(OH)_2$	ADDED GRAMS EQUIVALENT NaCN	ADDED GRAMS EQUIVALENT CaO	RESIDUAL g NaCN	RESIDUAL g CaO	CONSUMED g NaCN	CONSUMED g CaO	PH
	--	--	--	--	--	--	--	--	6.3
	--	3.00	--	2.19	--	--	--	--	11.9
Start	1.05	--	1.00	--	--	--	--	--	--
2	0.11	Nil	0.10	Nil	0.90	0.22	0.10	1.97	11.9
6	0.05	Nil	0.05	Nil	0.95	0.16	0.05	0.06	11.8
12	Nil	Nil	Nil	Nil	0.95	0.12	0.05	0.04	11.6
Total	1.21	3.00	1.15	2.19	0.95	0.12	0.20	2.07	

Cyanide sol'n: 770 ml
Wash sol'n: 1030 ml
Residue: 509.1 g

Reagents Consumption: Kg/t

NaCN: 0.40

CaO: 4.14

CYANIDATION TEST RESULTS

SAMPLE: WEIGHT - GR.: TEST NO.: 104

OBJECT OF TEST: DATE:

TEST BY:

OPERATION	Time Min.	% Solids	pH	Unit			Reagents - lbs/ton												GRIND Size	GRIND Wt%	

PRODUCT	Wt. GR Amount	Wt. %	ASSAYS g/t or mg/l Au							METAL CONTENT							DISTRIBUTION Au				
Cyanide Sol'n	770	ml	6.8														73.1				
Wash	1030	ml	1.5														21.6				
Residue	509.1	g	0.74														5.3				
Head (calc.)			14.1														100.0				

TEST NUMBER 105

CYANIDATION TEST RECORD

Object of Test: Determining optimum cyanidation time

Sol'n Conc. 1.0 g/l NaCN

Feed: 500 g;

Pulp Density: 33 % solids

Sol'n Vol. 1000 ml

Fineness: 15',65% solids, 73.8 - 200 mesh

Hours 24

Regents Balance

Time Cumul. hrs	ADDED GRAMS ACTUAL NaCN	ADDED GRAMS ACTUAL $Ca(OH)_2$	ADDED GRAMS EQUIVALENT NaCN	ADDED GRAMS EQUIVALENT CaO	RESIDUAL g NaCN	RESIDUAL g CaO	CONSUMED g NaCN	CONSUMED g CaO	pH
	--	--	--	--	--	--	--	--	6.3
	--	3.00	--	2.19	--	--	--	--	12.2
Start	1.05	--	1.00	--	--	--	--	--	--
2	--	--	--	--	0.75	0.16	0.25	2.03	11.7
	0.26	--	0.25	Nil	--	--	--	--	--
6	Nil	Nil	Nil	Nil	1.00	0.13	Nil	0.03	11.7
12	Nil	Nil	Nil	Nil	1.00	0.09	Nil	0.04	11.6
24	Nil	Nil	Nil	Nil	1.00	0.09	Nil	Nil	11.3
Total	1.31	3.00	1.25	2.19	1.00	0.09	0.25	2.10	

Cyanide sol'n: 710 ml
Wash sol'n: 985 ml
Residue: 510.6 g

Reagents Consumption: Kg/t

NaCN: 0.5

CaO: 4.2

CYANIDATION TEST RESULTS

SAMPLE:

WEIGHT - GR.:

TEST NO.: 105

OBJECT OF TEST:

DATE:

TEST BY:

OPERATION	Time Min.	% Solids	pH	Unit			Reagents - lbs/ton											GRIND Size	GRIND Wt%

PRODUCT	Wt. GR. Amount	Wt. %	ASSAYS g/t or mg/l Au							METAL CONTENT							DISTRIBUTION - % Au				
Cyanide Sol'n	710	ml	6.8														70.9				
Wash "	985	ml	1.8														26.0				
Residue	510.6	g	0.41														3.1				
Head (calc.)			13.3														100.0				

TEST NUMBER 106

CYANIDATION TEST RECORD

Object of Test: Determining optimum cyanidation time

Sol'n Conc. 1.0 g/ℓ NaCN

Feed: 500 g;

Pulp Density: 33 % solids

Sol'n Vol. 1000 ml

Fineness: -100 mesh (15',65% solids, 73.8% - 200 mesh

Hours 48

Regents Balance _____

Time Cumul. hrs	ADDED GRAMS ACTUAL NaCN	ADDED GRAMS ACTUAL $Ca(OH)_2$	ADDED GRAMS EQUIVALENT NaCN	ADDED GRAMS EQUIVALENT CaO	RESIDUAL g NaCN	RESIDUAL g CaO	CONSUMED g NaCN	CONSUMED g CaO	pH
	--	--	--	--	--	--	--	--	6.3
	--	3.00	--	2.19	--	--	--	--	12.2
Start	1.05	--	1.00	--	--	--	--	--	--
2	--	--	--	--	0.75	0.16	0.25	2.03	11.7
	0.26	Nil	0.25	Nil	--	--	--	--	--
6	Nil	Nil	Nil	Nil	1.00	0.13	Nil	0.03	11.7
12	Nil	Nil	Nil	Nil	1.00	0.09	Nil	0.04	11.6
24	Nil	Nil	Nil	Nil	1.00	0.09	Nil	Nil	11.3
30	Nil	Nil	Nil	Nil	1.00	0.08	Nil	0.01	11.3
36	Nil	Nil	Nil	Nil	1.00	0.08	Nil	Nil	11.3
48	Nil	Nil	Nil	Nil	0.95	0.08	0.05	Nil	11.1
Total	1.31	3.00	1.25	2.19	0.95	0.08	0.30	2.11	

Cyanide sol'n: 745 ml
Wash sol'n: 980 ml
Residue: 495.2 g

Reagents Consumption: Kg/t

NaCN: 0.6
CaO: 4.22

CYANIDATION TEST RESULTS

SAMPLE :

OBJECT OF TEST:

WEIGHT - GR. :

TEST NO.: 106

DATE:

TEST BY:

OPERATION	Time Min.	% Solids	pH	Unit			Reagents - lbs/ton											GRIND Size	GRIND Wt%

PRODUCT	Wt. GR Amount	Wt. %	ASSAYS g/t or mg/l Au							METAL CONTENT							DISTRIBUTION - % Au			
Cyanide Sol'n	745	ml	6.4														72.4			
Wash "	980	ml	1.6														23.8			
Residue	495.2	g	0.51														3.8			
Head (calc.)			13.3														100.0			

TEST NUMBER 107

CYANIDATION TEST RECORD

Object of Test: Determining optimum ore fineness

Feed: 500 g;

Sol'n Vol. 1000 ml

Hours 24

Sol'n Conc. 1.0 g/ℓ NaCN

Pulp Density: 33 % solids

Fineness: 45.7% - 200 mesh

Regents Balance _____

Time Cumul. hrs	ADDED GRAMS ACTUAL NaCN	ADDED GRAMS ACTUAL $Ca(OH)_2$	ADDED GRAMS EQUIVALENT NaCN	ADDED GRAMS EQUIVALENT CaO	RESIDUAL g NaCN	RESIDUAL g CaO	CONSUMED g NaCN	CONSUMED g CaO	PH
	--	--	--	--	--	--	--	--	7.0
	--	2.00	--	1.46	--	--	--	--	12.0
Start	1.05	--	1.00	--	--	--	--	--	--
2	--	--	--	--	0.95	0.06	0.05	1.40	11.0
	0.05	0.50	0.05	0.37	--	--	--	--	11.7
6	--	--	--	--	1.00	0.13	Nil	0.30	11.5
	Nil	Nil	Nil	Nil	--	--	--	--	--
12	--	--	--	--	1.00	0.10	Nil	0.03	11.3
	--	--	--	--	--	--	--	--	--
24	Nil	Nil	Nil	Nil	0.90	0.08	0.10	0.02	11.0
Total	1.10	2.50	1.05	1.83	0.90	0.08	0.15	1.75	

Cyanide sol'n: 760 ml
Wash sol'n: 1070 ml
Residue: 500.3 g

Reagents Consumption: Kg/t

NaCN: 0.3 kg/t

CaO: 3.5 kg/t

CYANIDATION TEST RESULTS

SAMPLE: WEIGHT - GR.: TEST NO.: 107

OBJECT OF TEST: DATE:

TEST BY:

OPERATION	Time Min.	% Solids	pH	Unit			Reagents - lbs/ton											GRIND Size	GRIND Wt%

PRODUCT	Wt. GR Amount	Wt. %	ASSAYS g/t or mg/l Au	METAL CONTENT	DISTRIBUTION Au
Cyanide Sol'n	760	ml	5.8		63.6
Wash "	1070	ml	1.0		15.5
Residue	500.3	g	2.9		20.9
Head (calc.)			13.8		100.0

TEST NUMBER 108

CYANIDATION TEST RECORD

Object of Test: Determining optimum ore fineness

Sol'n Conc. 1.0 g/l NaCN

Feed: 500 g;

Pulp Density: 33 % solids

Sol'n Vol. 1000 ml

Fineness: -65 mesh (5', 65% solids, 55.6%-200 mesh

Hours 24

Regents Balance

Time Cumul. hrs	ADDED GRAMS ACTUAL NaCN	ADDED GRAMS ACTUAL $Ca(OH)_2$	ADDED GRAMS EQUIVALENT NaCN	ADDED GRAMS EQUIVALENT CaO	RESIDUAL g NaCN	RESIDUAL g CaO	CONSUMED g NaCN	CONSUMED g CaO	PH
	--	--	--	--	--	--	--	--	6.9
	--	2.00	--	1.46	--	--	--	--	11.9
Start	1.05	--	1.00	--	--	--	--	--	--
2	--	--	--	--	0.85	.07	0.15	1.39	11.2
	0.16	0.50	0.15	0.37					11.8
6					1.00	0.16	Nil	0.28	11.6
	Nil	Nil	Nil	Nil	--	--	--	--	--
12	--	--	--	--	0.95	0.11	0.05	0.05	11.3
	0.05	Nil	0.05	Nil	--	--	--	--	--
24	--	--	--	--	0.95	0.09	0.05	0.02	11.1
Total	1.26	2.50	1.20	1.83	0.95	0.09	0.25	1.74	

Cyanide sol'n: 680 ml
Wash sol'n: 990 ml
Residue: 503 g

Reagents Consumption: Kg/t

NaCN: 0.5 kg/t
CaO: 3.48 kg/t

CYANIDATION TEST RESULTS

SAMPLE :

OBJECT OF TEST:

WEIGHT - GR.

TEST NO.: 108

DATE:

TEST BY:

OPERATION	Time Min.	% Solids	pH	Unit			Reagents - lbs/ton												GRIND Size	GRIND Wt %

PRODUCT	Wt. GR Amount	Wt. %	ASSAYS g/t or mg/l Au								METAL CONTENT								DISTRIBUTION - % Au			
Cyanide Sol'n	680	ml	5.7																67.6			
Wash "	990	ml	1.4																24.2			
Residue	503	g	0.93																8.2			
Head (calc.)			11.4																100.0			

TEST NUMBER 109

CYANIDATION TEST RECORD

Object of Test: Determining optimum ore fineness

Feed: 500 g;

Sol'n Vol. 1000 ml

Hours 24

Sol'n Conc. 1.0 g/ℓ NaCN

Pulp Density: 33 % solids

Fineness: -100 mesh (15 min., 65% solids, 73.8% - 200 mesh)

Regents Balance

Time Cumul. hrs	ADDED GRAMS ACTUAL NaCN	ADDED GRAMS ACTUAL $Ca(OH)_2$	ADDED GRAMS EQUIVALENT NaCN	ADDED GRAMS EQUIVALENT CaO	RESIDUAL g NaCN	RESIDUAL g CaO	CONSUMED g NaCN	CONSUMED g CaO	PH
	--	--	--	--	--	--	--	--	8.0
		3.00		2.19					12.3
Start	1.05	--	1.00	--	--	--	--	--	--
2	--	--	--	--	0.90	0.34	0.10	1.85	12.0
	0.11	Nil	0.10	Nil	--	--	--	--	--
6	--	--	--	--	1.0	0.22	Nil	0.12	11.8
	Nil	Nil	Nil	Nil	--	--	--	--	--
11	--	--	--	--	0.95	0.19	0.05	0.03	11.6
	0.05	Nil	0.05	Nil	--	--	--	--	--
24	--	--	--	--	1.00	0.15	Nil	0.04	11.6
Total	1.21	3.00	1.15	2.19	1.00	0.15	0.15	2.04	

Cyanide sol'n: 755 ml
Wash sol'n: 985 ml
Residue: 468.1 g

Reagents Consumption: Kg/t

NaCN: 0.3
CaO: 4.08

SAMPLE :

CYANIDATION TEST RESULTS

OBJECT OF TEST:

WEIGHT - GR .

TEST NO.: 109

DATE:

TEST BY:

OPERATION	Time Min.	% Solids	pH	Unit			Reagents - lbs/ton											GRIND Size	GRIND Wt%

PRODUCT	Wt. GR Amount	Wt. %	ASSAYS g/t or mg/l Au							METAL CONTENT							DISTRIBUTION - % Au
Cyanide Sol'n	755		5.8														72.8
Wash "	985		1.4														22.9
Residue	468.1		0.55														4.3
Head (calc.)			12.9														100.0

CYANIDATION TEST RECORD

TEST NUMBER 110

Object of Test: Determining optimum ore fineness

Feed: 500 g;

Sol'n Vol. 1000 ml

Hours 24

Sol'n Conc. 1.0 g/ℓ NaCN

Pulp Density: 33 % solids

Fineness: -200 mesh(35 min.,65% solids, 95.3% - 200 mesh)

Regents Balance

Time Cumul. hrs	ADDED GRAMS ACTUAL NaCN	ADDED GRAMS ACTUAL $Ca(OH)_2$	ADDED GRAMS EQUIVALENT NaCN	ADDED GRAMS EQUIVALENT CaO	RESIDUAL g NaCN	RESIDUAL g CaO	CONSUMED g NaCN	CONSUMED g CaO	PH
	--	--	--	--	--	--	--	--	8.1
	--	3.00	--	2.19	--	--	--	--	12.2
Start	1.05	--	1.00	--	--	--	--	--	--
2	--	--	--	--	0.65	0.24	0.35	1.95	11.9
	0.37	Nil	0.35	Nil	--	--	--	--	--
6	--	--	--	--	1.00	0.15	Nil	0.09	11.7
	Nil	Nil	Nil	Nil	--	--	--	--	--
11	--	--	--	--	1.00	0.13	Nil	0.02	11.5
	Nil	Nil	Nil	Nil	--	--	--	--	--
24	--	--	--	--	0.95	0.10	0.05	0.03	11.4
Total	1.42	3.00	1.35	2.19	0.95	0.10	0.40	2.09	

Cyanide sol'n: 700 ml
Wash sol'n: 980 ml
Residue: 499.3 g

Reagents Consumption: Kg/t

NaCN: 0.8

CaO: 4.18

CYANIDATION TEST RESULTS

SAMPLE:

WEIGHT - GR. 500

TEST NO.: 110

OBJECT OF TEST:

DATE:

TEST BY:

OPERATION	Time Min.	% Solids	pH	Unit			Reagents - lbs/ton												GRIND Size	GRIND Wt%

PRODUCT	Wt. GR Amount	Wt. %	ASSAYS g/t or mg/l Au							METAL CONTENT							DISTRIBUTION - % Au				
Cyanide Sol'n	700	ml	6.2														71.2				
Wash "	980	ml	6.2														25.7				
Residue	499.3	g	0.38														3.1				
Head (calc.)			12.2														100.0				

Appendix 4

Flotation and Cyanidation of the Concentrate

Tests 10 & 111

15 & 112

16 & 116a and b

Conditions and Results

FLOTATION TEST REPORT

SAMPLE: _____ WEIGHT-GR.: 5 x 1000 TEST NO.: 10

OBJECT OF TEST: Obtain a flotation concentrate for cyanidation test. DATE: _____

TEST BY: _____

OPERATION	Time Min.	% Solids	pH	Unit			Reagents - g/t 208	Z-14	MIBC										GRIND Mesh Size	GRIND Wt %	REMARKS
Grinding	15	65																	-200	73.8	
Conditioning	3						100	50													
"	1								52												
Flot.Ro. Conc.)	3 1/2																				
Conditioning	3						100	50													
"	1								27												
Flot.RoConc-2	3																				
Conditioning	3						100	50													
"	1								27												
Flot.RoConc-3	2																				

PRODUCT	Wt. GR.	Wt. %	ASSAYS								METAL CONTENT								DISTRIBUTION - %							

TEST NUMBER 111

CYANIDATION TEST RECORD

Object of Test: Cyanidation of the flotation concentrate

Feed: 435.5 g;

Sol'n Vol. 988 ml

Hours 24

Sol'n Conc. 1.0 g/ℓ NaCN

Pulp Density: 30 % solids

Fineness: 94% - 400 mesh

Regents Balance

Time Cumul. hrs	ADDED GRAMS ACTUAL NaCN	ADDED GRAMS ACTUAL $Ca(OH)_2$	ADDED GRAMS EQUIVALENT NaCN	ADDED GRAMS EQUIVALENT CaO	RESIDUAL g NaCN	RESIDUAL g CaO	CONSUMED g NaCN	CONSUMED g CaO	PH
									8.3
Start		5.00		3.65					11.4
	1.05		1.0						
2					0.60	0.03	0.40	3.62	10.3
	0.42	2.00	0.40	1.46					11.7
6					0.90	0.07	0.10	1.42	11.5
	0.105	Nil	0.10	Nil					
10					0.90	0.06	0.10	0.01	11.2
	0.105	Nil	0.10	Nil					
24					0.90	0.06	0.10	Nil	10.9
Total	1.680	7.00	1.60	5.11	0.90	0.06	0.70	5.05	

Cyanide sol'n: 705 ml
Wash sol'n: 1000 ml
Residue: 435.5 g

Reagents Consumption: Kg/t

	Kg/t of conc.	Kg/t of ore
NaCN:	1.6	0.152
CaO:	11.6	1.102

FLOTATION AND CYANIDATION RESULTS

WEIGHT - GR.:

TEST NO.: 10 and 111

TEST: Flotation followed by 24 hours cyanidation of the concentrate

DATE:

TEST BY:

Flotation	Time Min.	% Solids	pH	Unit			Reagents - lbs/ton												GRIND Size	GRIND Wt%	REMARKS

PRODUCT	Wt. Amount	Wt. %	ASSAYS g/t or mg/l Au	METAL CONTENT	DISTRIBUTION - % Au Ind.	DISTRIBUTION - % Au O/A
Flotation						
Concentrate		9.5	132.0		92.0	
Tailing		90.5	1.2		8.0	
Head		100.0	13.6		100.0	
Cyanidation					52.4	48.2
Cyanide Sol'n	705	ml	35.6		20.1	18.5
Wash	1000	ml	9.6		27.5	25.3
Residue	435.5	g	30.2		100.0	52.0
Head (flot. conc)	435.5	g	109.9			
						66.7
Flotation +Cyanidation						33.3
Cyanide +Wash Sol'n			20.4			100.0
Total Tails			4.0			
Head			13.6			

FLOTATION TEST REPORT

WEIGHT-GR.: 5 - 1000

TEST NO.: 15

DATE:

TEST BY:

T: Obtain a flotation concentrate for cyanidation test.

PRODUCT	Time Min	% Solids	pH	Unit			Reagents - g/t 208	Z-14	MIBC	GRIND Mesh Size	GRIND Wt%	REMARKS
Grinding	15	65								-200	73.8	
Conditioning	3						100	50				
"	1								52			
Flot.RoConc-1	3 1/2											
Conditioning	3						100	50				
"	1								27			
Flot.RoConc-2	3											
Conditioning	3						100	50				
"	1								27			
Flot RoConc-3	2											

PRODUCT	Wt. GR	Wt. %	ASSAYS							METAL CONTENT							DISTRIBUTION - %						

CYANIDATION TEST RECORD

TEST NUMBER 112

Object of Test: Cyanidation of the flotation concentrate

Sol'n Conc. 1.0 g/l NaCN

Feed: 535.0 g;

Pulp Density: 30 % solids

Sol'n Vol. 1240 ml

Fineness: 95.6% - 400 mesh

Hours 48

Regents Balance

Time Cumul. hrs	ADDED GRAMS ACTUAL NaCN	ADDED GRAMS ACTUAL $Ca(OH)_2$	ADDED GRAMS EQUIVALENT NaCN	ADDED GRAMS EQUIVALENT CaO	RESIDUAL g NaCN	RESIDUAL g CaO	CONSUMED g NaCN	CONSUMED g CaO	PH
	--	--	--	--	--	--	--	--	9.2
	--	6.00	--	4.38	--	--	--	--	11.8
Start	1.31	--	1.24	--	--	--	--	--	11.9
3	--	--	--	--	0.25	0.02	0.99	4.36	10.9
	1.05	2.00	1.00	1.46	--	--	--	--	12.0
6	--	--	--	--	0.95	0.19	0.30	1.29	11.7
	0.32	Nil	0.30	Nil	--	--	--	--	--
9½	--	--	--	--	1.25	0.13	Nil	0.06	11.6
	Nil	Nil	Nil	Nil	--	--	--	--	--
24	--	--	--	--	1.05	0.09	0.20	0.04	11.2
	0.21	Nil	0.20	Nil	--	--	--	--	--
Total									

Cyanide sol'n:
Wash sol'n:
Residue:

Reagents Consumption: Kg/t

NaCN:

CaO:

TEST NUMBER 112
continued

CYANIDATION TEST RECORD

Object of Test: _____

Feed: _____ g;

Sol'n Vol. _____ ml

Hours _____

Sol'n Conc. _____ g/ℓ NaCN

Pulp Density: _____ % solids

Fineness: _____

Regents Balance _____

Time Cumul. hrs	ADDED GRAMS ACTUAL NaCN	ADDED GRAMS ACTUAL $Ca(OH)_2$	ADDED GRAMS EQUIVALENT NaCN	ADDED GRAMS EQUIVALENT CaO	RESIDUAL g NaCN	RESIDUAL g CaO	CONSUMED g NaCN	CONSUMED g CaO	PH
27	--	--	--	Nil	1.20	0.09	0.05	Nil	11.1
	0.05	050	0.05	0.37	--	--	--	--	--
30	--	--	--	--	1.25	0.45	Nil	0.01	11.6
	Nil	Nil	Nil	Nil	--	--	--	--	--
33½	--	--	--	--	1.25	0.42	Nil	0.03	11.6
	Nil	Nil	Nil	Nil	--	--	--	--	--
48	--	--	--	--	1.15	0.40	0.10	0.02	11.3
Total	2.94	8.50	2.79	6.21	1.15	0.40	1.64	5.81	

Cyanide sol'n: 850 ml
Wash sol'n: 1025 ml
Residue: 535 g

Reagents Consumption: Kg/t

	Kg/t of conc.	Kg/t of ore
NaCN:	3.065	0.368
CaO:	10.860	1.303

FLOTATION AND CYANIDATION TEST RESULTS

WEIGHT - GR.:

TEST NO.: 15 and 112

DATE:

TEST BY:

TEST: Flotation followed by 48 hours cyanidation of the reground concentrate.

OPERATION	Time Min.	% Solids	pH	Unit			Reagents - lbs/ton											GRIND Size	GRIND Wt%	REMARKS

PRODUCT	Wt. GR	Wt. %	ASSAYS g/t or mg/l Au	METAL CONTENT	DISTRIBUTION - % Au Ind	DISTRIBUTION - % Au O/A
Flotation						
Concentrate		12.0	97.7		92.4	
Tailing		88.0	1.1		7.6	
Head		100.0	12.7		100.0	
Cyanidation	Amount					
Cyanide Sol'n	850	ml	38.0		71.3	65.9
Wash	1025	ml	12.0		27.2	25.1
Residue	535	g	1.3		1.5	1.4
Head (Flot.Conc)	535	g	84.7		100.0	92.4
Flotation +Cyanidation						
Cyanide +Wash Sol'n			23.8			91.0
Total Tails			1.1			9.0
Head			12.7			100.0

FLOTATION TEST REPORT

WEIGHT - GR. 5 x 1000

TEST NO.: 16

DATE:

TEST BY:

T: Obtain a flotation concentrate for cyanidation test.

PRODUCT	Time Min.	% Solids	pH	Unit	Reagents - g/t 208	317	MIBC	GRIND Mesh Size	GRIND Wt%	REMARKS
Grinding	15	65						-200	73.8	
Conditioning	3				100	50	52			
Flot. RoConc-1	3 1/2									
Conditioning	3				100	50	27			
Flot. RoConc-2	3									
Conditioning	3				100	50	27			
Flot. RoConc-3	2									

PRODUCT	Wt. GR.	Wt. %	ASSAYS	METAL CONTENT	DISTRIBUTION - %

CYANIDATION TEST RECORD

TEST NUMBER 116a and b

Object of Test: Cyanidation of the flotation concentrate

Sol'n Conc. 1.0 g/l NaCN

Feed: 394.0 g;

Pulp Density: 30 % solids

Sol'n Vol. 1000 ml

Fineness: 95% - 400 mesh

Hours 24 and 48

Regents Balance

Time Cumul. hrs	ADDED GRAMS ACTUAL NaCN	ADDED GRAMS ACTUAL $Ca(OH)_2$	ADDED GRAMS EQUIVALENT NaCN	ADDED GRAMS EQUIVALENT CaO	RESIDUAL g NaCN	RESIDUAL g CaO	CONSUMED g NaCN	CONSUMED g CaO	PH
	--	3.00	--	2.19	--	--	--	--	11.6
Start	1.05	--	1.00	--	--	--	--	--	--
3	--	--	--	--	0.25	0.02	0.75	2.17	9.7
	0.79	2.00	0.75	1.46	--	--	--	--	11.4
6	--	--	--	--	0.85	0.02	0.15	1.46	10.7
	0.16	0.50	0.15	0.36	--	--	--	--	11.4
12	--	--	--	--	0.90	0.04	0.10	0.34	10.5
	0.11	0.50	0.10	0.36	--	--	--	--	--
24	--	--	--	--	0.85	0.06	0.15	0.34	10.9
Total 24hours	2.11	6.00	2.00	4.37	0.85	0.06	1.15	4.31	
Total									

Cyanide sol'n:

Wash sol'n:

Residue:

Reagents Consumption: Kg/t

NaCN:

CaO:

CYANIDATION TEST RECORD

TEST NUMBER 116a and b continued

Object of Test: _____

Sol'n Conc. _____ g/ℓ NaCN

Feed: _____ g;

Pulp Density: _____ % solids

Sol'n Vol. _____ ml

Fineness: _____

Hours _____

Regents Balance _____

Time Cumul. hrs	ADDED GRAMS ACTUAL NaCN	ADDED GRAMS ACTUAL $Ca(OH)_2$	ADDED GRAMS EQUIVALENT NaCN	ADDED GRAMS EQUIVALENT CaO	RESIDUAL g NaCN	RESIDUAL g CaO	CONSUMED g NaCN	CONSUMED g CaO	pH
Filter and obtain 24 hours cyanide and wash solutions, then restart cyanidation using fresh solution.									
	--	3.00	--	2.19	--	--	--	--	11.9
24	1.05	--	1.00	--	--	--	--	--	--
27	--	--	--	--	0.95	0.46	0.05	1.73	12.0
	0.05	Nil	0.05	Nil	--	--	--	--	--
36	--	--	--	--	0.95	0.32	0.05	0.14	11.8
	0.05	Nil	0.05	Nil	--	--	--	--	--
48	--	--	--	--	0.95	0.25	0.05	0.07	11.6
Total 48 hours	3.26	9.00	3.10	6.56	1.80	0.31	1.30	6.25	
XXXXX	(A) 0-24 hrs.	(B) 24-48 hrs.					(A)		(B)

	(A) 0-24 hrs.	(B) 24-48 hrs.
Cyanide sol'n:	640 ml	780
Wash sol'n:	1500 ml	1470
Residue: g	394 g	394

Reagents Consumption: Kg/t

	24 hrs. Kg/t of conc	24 hrs. Kg/t of ore	48 hrs. Kg/t of conc	48 hrs. kg/t of ore
NaCN:	2.9	0.247	3.3	0.281
Cao:	10.9	0.927	16.0	1.360

FLOTATION AND CYANIDATION TEST RESULTS

WEIGHT - GR :

TEST NO: 16 and 116d

DATE:

TEST BY:

T: Flotation followed by 24 hours cyanidation of the reground concentrate

CONDITIONS	Time Min.	% Solids	pH	Unit			Reagents - lbs/ton												GRIND Size	GRIND Wt%	REMARKS

PRODUCT	Wt. GR	Wt. %	ASSAYS g/t or mg/l Au	Ag	S %	METAL CONTENT	DISTRIBUTION - % Au Ind	Au O/A	Ag Ind	Ag O/A	S
Flotation											
Concentrate		8.5	125.1	16.1	0.42		91.4		76.5		80.0
Tailing		91.5	1.1	0.46	0.01		8.6		23.5		20.0
Head		100.0	11.0	1.7	0.43		100.0		100.0		100.0
Cyanidation	Amount										
Cyanide Sol'n	640	ml	45.6	1.05							
Wash	1500	ml	5.3	2.80							
Residue	394	g	30.9	3.69			59.2	54.1	10.6	8.1	
Head (Flot.Conc)			124.4	17.3			16.1	14.7	66.4	50.8	
							24.7	22.6	23.0	17.6	
							100.0	91.4	100.0	76.5	
Flotation & cyanidation											
Cyanide wash Sol'n			17.4	2.3							
Total tails			3.5	0.7				68.8		58.9	
Head			11.0	1.7				31.2		41.1	
								100.0		100.0	

FLOTATION AND CYANIDATION TEST RESULTS

WEIGHT - GR.:

TEST NO.: 16 and 116 b

DATE:

TEST BY:

Flotation followed by 48 hours cyanidation of the reground concentrate.

Operation	Time Min.	% Solids	pH	Unit			Reagents - lbs/ton												GRIND Size	GRIND Wt%	REMARKS

PRODUCT	Wt GR	Wt %	ASSAYS g/t or mg/l Au	Ag	S %	METAL CONTENT								DISTRIBUTION - % Au Ind	Au O/A	Ag Ind	Ag O/A	S			
Flotation																					
Concentrate		8.5	125.1	16.1	0.42									91.4		76.5		80.0			
Tailing		91.5	1.1	0.46	0.01									8.6		23.5		20.0			
Head		100.0	11.0	1.7	0.43									100.0		100.0		100.0			
Cyanidation	Amount																				
Cyanide Sol'n	1420	ml	26.0	1.0										75.0	68.6	22.0	16.8				
Wash	29.70	ml	3.5	1.5										21.2	19.4	70.6	54.0				
Residue	394	g	4.8	1.2										3.8	3.4	7.4	5.7				
Head (Flot.Conc)			125.	16.1										100.0	91.4	100.0	76.5				
Flotation & Cyanidation																					
Cyanide-Wash Sol'n			10.4	1.3											88.0		70.8				
Total Tails			1.4	0.5											12.0		29.2				
Head			11.0	1.7											100.0		100.0				